CLAIMS

1. A computer-implemented method for filtering an image including a plurality of pixels, the method comprising:

receiving a filter kernel to determine one or more filtered values for each pixel in a sequence of pixels in the image, adjacent pixels in the sequence being separated by a characteristic distance in the image, the filter kernel specifying filtering weights for pixels in a neighborhood surrounding a center of the filter kernel;

defining a difference kernel based on local differences between a first kernel and a second kernel, the first and second kernels being defined by the filter kernel centered at a first location and a second location, respectively, the second location being separated from the first location by the characteristic distance separating adjacent pixels in the sequence, the difference kernel specifying difference weights for pixels in a neighborhood surrounding a center of the difference kernel; and

using the difference kernel to determine a difference between a filtered value of a current pixel and a filtered value of a previous pixel that is adjacent to the current pixel in the sequence.

2. The method of claim 1, further comprising:

determining the filtered value of the current pixel based on the filtered value of the previous pixel and the difference between the filtered values of the current pixel and the previous pixel.

3. The method of claim 1, wherein:

the filter kernel specifies substantially uniform filtering weights for pixels in a region within the neighborhood surrounding the center of the filter kernel.

4. The method of claim 1, wherein:

the filter kernel specifies substantially non-zero filtering weights for pixels in one or more regions having convex or concave shapes within the neighborhood surrounding the center of the filter kernel.

5. The method of claim 4, wherein:

the filter kernel specifies substantially non-zero filtering weights for pixels in a circular or elliptical region within the neighborhood surrounding the center of the filter kernel.

6. The method of claim 1, wherein:

each pixel in the sequence specifies substantially the same value for a local attribute of the image; and

receiving a filter kernel includes receiving a filter kernel that is based upon the same value of the local attribute.

7. The method of claim 6, wherein the local attribute is a depth value corresponding to a distance of objects represented by pixels in the sequence relative to a focal distance.

8. The method of claim 6, wherein the local attribute is a luminance of pixels in the sequence.

9. The method of claim 1, further comprising:

using the filter kernel directly to determine a filtered value of a first pixel in the sequence of pixels; and

using the difference kernel to determine a filtered value for each subsequent pixel following the first pixel in the sequence of pixels.

10. The method of claim 1, wherein:

the characteristic distance is defined by neighboring pixels in the image.

11. The method of claim 1, wherein:

the pixels in the sequence are arranged in a single direction in the image.

12. The method of claim 11, wherein the pixels in the image are arranged in a rectangular array and the sequence of pixels includes pixels in a row, a column or a diagonal of the rectangular array.

13. The method of claim 1, wherein defining the difference kernel based on local differences between the first kernel and the second kernel includes:

identifying difference pixels in the neighborhood surrounding the center of the difference kernel, for each difference pixel, the first kernel and the second kernel specifying substantially different filtering weights; and

defining a substantially non-zero difference weight for each difference pixel.

14. The method of claim 13, wherein:

for each difference pixel, defining a substantially non-zero difference weight includes defining a difference weight that is proportional to the difference between the filtering weights specified for the pixel by the first and second kernels.

15. The method of claim 13, wherein:

identifying difference pixels includes generating a list of relative positions of the identified pixels in the neighborhood surrounding the center of the difference kernel; and

using the difference kernel to determine the difference between the filtered values of the current pixel and the previous pixel includes using the list of relative positions to identify current difference pixels that have a substantially non-zero difference weight when the difference kernel is centered at the current pixel.

16. The method of claim 13, wherein using the difference kernel to determine the difference between the filtered values of the current pixel and the previous pixel includes:

for each difference pixel, determining a corresponding local contribution based on the difference weight and a pixel value of the difference pixel; and

summing up the corresponding local contribution of each difference pixel to determine the difference between the filtered values of the current pixel and the previous pixel.

17. The method of claim 16, wherein:

each pixel in the sequence has substantially the same depth value; and

for each difference pixel, determining the corresponding local contribution includes determining a substantially zero local contribution if the difference pixel has a depth value that is

substantially different from the same depth value of the pixels in the sequence.

18. The method of claim 1, further comprising:

receiving a next filter kernel to determine one or more filtered values for each pixel in a next sequence of pixels in the image;

defining a next difference kernel based on local differences between two kernels that are defined by the next filter kernel centered at adjacent pixels in the next sequence; and

using the next difference kernel to determine differences between filtered values of adjacent pixels in the next sequence.

19. A computer-implemented method for depth of field filtering an image including a plurality of pixels, the method comprising:

receiving a blur filter kernel to determine one or more blurred values for each pixel in a sequence of pixels in the image, each pixel in the sequence having substantially the same depth value, adjacent pixels in the sequence being separated by a characteristic distance in the image;

defining a difference kernel based on local differences between a first kernel and a second kernel, the first and second kernels being defined by the blur filter kernel centered at a first location and a second location, respectively, the second location being separated from the first location by the characteristic distance separating adjacent pixels in the sequence, the difference kernel specifying difference weights for pixels in a neighborhood surrounding a center of the difference kernel;

using the blur filter kernel directly to determine a blurred value of a first pixel in the sequence; and

using the difference kernel to determine a blurred value of each subsequent pixel following the first pixel in the sequence.

20. A software product, tangibly embodied in an information carrier, for filtering an image including a plurality of pixels, the software product comprising instructions operable to cause one or more data processing apparatus to perform operations comprising:

receiving a filter kernel to determine one or more filtered values for each pixel in a

sequence of pixels in the image, adjacent pixels in the sequence being separated by a characteristic distance in the image, the filter kernel specifying filtering weights for pixels in a neighborhood surrounding a center of the filter kernel;

defining a difference kernel based on local differences between a first kernel and a second kernel, the first and second kernels being defined by the filter kernel centered at a first location and a second location, respectively, the second location being separated from the first location by the characteristic distance separating adjacent pixels in the sequence, the difference kernel specifying difference weights for pixels in a neighborhood surrounding a center of the difference kernel; and

using the difference kernel to determine a difference between a filtered value of a current pixel and a filtered value of a previous pixel that is adjacent to the current pixel in the sequence.

21. The software product of claim 20, further comprising instructions operable to cause one or more data processing apparatus to perform operations comprising:

determining the filtered value of the current pixel based on the filtered value of the previous pixel and the difference between the filtered values of the current pixel and the previous pixel.

22. The software product of claim 20, wherein:

the filter kernel specifies substantially uniform filtering weights for pixels in a region within the neighborhood surrounding the center of the filter kernel.

23. The software product of claim 20, wherein:

the filter kernel specifies substantially non-zero filtering weights for pixels in one or more regions having convex or concave shapes within the neighborhood surrounding the center of the filter kernel.

24. The software product of claim 23, wherein:

the filter kernel specifies substantially non-zero filtering weights for pixels in a circular or elliptical region within the neighborhood surrounding the center of the filter kernel.

25. The software product of claim 20, wherein:

each pixel in the sequence specifies substantially the same value for a local attribute of the image; and

receiving a filter kernel includes receiving a filter kernel that is based upon the same value of the local attribute.

26. The software product of claim 25, wherein the local attribute is a depth value corresponding to a distance of objects represented by pixels in the sequence relative to a focal distance.

27. The software product of claim 25, wherein the local attribute is a luminance of pixels in the sequence.

28. The software product of claim 20, further comprising instructions operable to cause one or more data processing apparatus to perform operations comprising:

using the filter kernel directly to determine a filtered value of a first pixel in the sequence of pixels; and

using the difference kernel to determine a filtered value for each subsequent pixel following the first pixel in the sequence of pixels.

29. The software product of claim 20, wherein:

the characteristic distance is defined by neighboring pixels in the image.

30. The software product of claim 20, wherein:

the pixels in the sequence are arranged in a single direction in the image.

31. The software product of claim 30, wherein the pixels in the image are arranged in a rectangular array and the sequence of pixels includes pixels in a row, a column or a diagonal of the rectangular array.

32. The software product of claim 20, wherein defining the difference kernel based on local differences between the first kernel and the second kernel includes:

identifying difference pixels in the neighborhood surrounding the center of the difference kernel, for each difference pixel, the first kernel and the second kernel specifying substantially different filtering weights; and

defining a substantially non-zero difference weight for each difference pixel.

33. The software product of claim 32, wherein:

for each difference pixel, defining a substantially non-zero difference weight includes defining a difference weight that is proportional to the difference between the filtering weights specified for the pixel by the first and second kernels.

34. The software product of claim 32, wherein:

identifying difference pixels includes generating a list of relative positions of the identified pixels in the neighborhood surrounding the center of the difference kernel; and

using the difference kernel to determine the difference between the filtered values of the current pixel and the previous pixel includes using the list of relative positions to identify current difference pixels that have a substantially non-zero difference weight when the difference kernel is centered at the current pixel.

35. The software product of claim 32, wherein using the difference kernel to determine the difference between the filtered values of the current pixel and the previous pixel includes:

for each difference pixel, determining a corresponding local contribution based on the difference weight and a pixel value of the difference pixel; and

summing up the corresponding local contribution of each difference pixel to determine the difference between the filtered values of the current pixel and the previous pixel.

36. The software product of claim 35, wherein:

each pixel in the sequence has substantially the same depth value; and

for each difference pixel, determining the corresponding local contribution includes determining a substantially zero local contribution if the difference pixel has a depth value that is substantially different from the same depth value of the pixels in the sequence.

37. The software product of claim 20, further comprising instructions operable to cause one or more data processing apparatus to perform operations comprising:

receiving a next filter kernel to determine one or more filtered values for each pixel in a next sequence of pixels in the image;

defining a next difference kernel based on local differences between two kernels that are defined by the next filter kernel centered at adjacent pixels in the next sequence; and

using the next difference kernel to determine differences between filtered values of adjacent pixels in the next sequence.

38. A software product, tangibly embodied in an information carrier, for depth of field filtering an image including a plurality of pixels, the software product comprising instructions operable to cause one or more data processing apparatus to perform operations comprising:

receiving a blur filter kernel to determine one or more blurred values for each pixel in a sequence of pixels in the image, each pixel in the sequence having substantially the same depth value, adjacent pixels in the sequence being separated by a characteristic distance in the image;

defining a difference kernel based on local differences between a first kernel and a second kernel, the first and second kernels being defined by the blur filter kernel centered at a first location and a second location, respectively, the second location being separated from the first location by the characteristic distance separating adjacent pixels in the sequence, the difference kernel specifying difference weights for pixels in a neighborhood surrounding a center of the difference kernel;

using the blur filter kernel directly to determine a blurred value of a first pixel in the sequence; and

using the difference kernel to determine a blurred value of each subsequent pixel following the first pixel in the sequence.